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Cloud computing is revolutionizing the ability for organizations and people to access information not seen at any point in our past. The linear model of passing information from one user to another is quickly being replaced by placing data, applications, and software in a centralized location or “cloud” in order to users to access at anytime or anywhere. This creates significant cost savings to organizations and establishes an efficient model to pass and share information quickly. Money can be saved through reduced operating and capital costs to an organization’s Information Technology structure. The Federal Government is taking notice and has established policy for all agencies to adopt cloud computing, where appropriate, within their organizations. The Marine Corps has moved towards cloud computing, but needs to fully implement the cloud in order to maximize the benefits of cost savings and reduced manpower within the Marine Corps

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MASTER OF MILITARY STUDIES

TITLE:
Cloud Computing in the Marine Corps. Needed innovation.

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
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Title: Cloud Computing in the Marine Corps. Needed innovation.

Author: Major Timothy Hough, United States Marine Corps

Thesis: The Marine Corps needs to fully utilize the power of cloud computing in order to reduce spending and manpower, ultimately providing efficiency and savings.

Discussion: Innovation in technology today is moving at an ever quickening pace. Efficiencies and convenience are being discovered and created in the private sector on a daily basis. Computing is not exempt from this concept. In the past users of computers were forced to remain at their desk and work from a single workstation. This created the need for organizations to enlist a large Information Technology (IT) workforce in order to accommodate the requirement to readily respond to computing problems ranging from software patches to resolving hardware problems. As computers grew in popularity over the past three decades the amount of data users have stored has risen. The creation of cloud computing is a natural evolution to solving these aforementioned issues. Rather than passing information from one user to another in a linear pattern, cloud computing places the data in a centralized location for all users to access on demand. This centralization of data relies on the users having access through an internet connection. The result is the ability to access your information from anywhere in the world, provided you access to the internet. By transferring storage and hosting of software to a centralized location, organizations can transfer many of their IT costs to the cloud services provider, as well as, increase the efficiency of its workforce through increased access to their information. This ability to transfer costs normally assumed by an organization to a third party has applications within the Federal Government as it faces a depressed economy. The Marine Corps is no different. The desire to cut defense spending in order to assist the overall Federal budget has left Marine Corps leadership with difficult decisions on where to trim unnecessary spending. Cloud computing can alleviate the pressure to cut programs or reduce the service workforce. Moving to a full cloud computing environment will positively increase access to information, as well as, reduce operating costs across the Marine Corps IT environment. This paper intends to demonstrate what cloud computing is, its background, and the positive applications it can have on the Marine Corps.

Conclusion: Cloud computing will be the future of the computing for the private sector, as well as public institutions. It is cost effective and a successful business model, if executed correctly. The federal government has taken notice and implemented policy to push into the realm of cloud computing, The Marine Corps needs to fully adopt this new paradigm in order to save money and reduce manpower during this restrictive economic environment.

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

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Preface

The purpose of this paper is to demonstrate the utility of cloud computing and the efficiency it brings to an organization, specifically the United States Marine Corps. As a result of changing the paradigm of computing and access to information, cloud computing offers the opportunity to save real money and reduce manpower. As the United States economy faces overwhelming debt and federal agencies compete for shrinking dollars, the Marine Corps should consider moving fully to a cloud computing strategy in order to save money and manpower.

Assistance and support from this project was received from the Gray Research Library, specifically, Ms. Rachel Kincaid. Additionally assistance was received from Major Shawn Kelly, Major Chris Beckford (Ret), and Bruce Sabol. These gentlemen provided me information and understanding of cloud computing as it applies to the world and its basis within the Federal Government, specifically the Department of Defense. Additionally, I received support from my research mentor Dr. Richard DiNardo who provided me the guidance to branch out on this relatively new topic within the Federal Government.

Introduction

Today's technological environment is expanding at an ever-increasing pace. Equipment and technologies believed to be current are typically obsolete within six months to a year of release. Access to the World Wide Web, or the internet as it is commonly referred to, has increased exponentially since its introduction in 1982 when the Advanced Research Projects Agency (ARPA) facilitated the ability for their ARPANET to be networked throughout the world. Since then the world has increasingly become smaller. Subsequently the modern workspace as it was known has become increasingly irrelevant. This irrelevance is a result of the expansion of technology within computing and through mobile platforms, such as tablets, smartphones, and laptops. This expansion has created an environment that provides the consumer with the ability to access information in any environment and any place. So long as the he or she has access to a satellite and/or a wireless router information can be consumed, downloaded, and stored through the internet.

One negative consequence of the rise of these mobile platforms is the amount of data that can be processed and ultimately the storage that is required to maintain the data. Additionally, because the world is becoming more connected, less and less are people working at a stationary desk or workspace and often able travel, while accessing work or information they desire. The rise of technology has not only turned the modern work day on its head, it has also changed the idea of a workspace and the ability to access the information residing on your computer from anywhere.

This ability to access information via the internet is the essence of cloud computing. It provides the ability for the user to access documents, information, applications, or software anywhere in the world, on any computer, as it is all stored in what is referred to as a "cloud".

The cloud provides the ability to reduce the amount of hardware and software that was originally utilized. Subsequently resources, such as money and human capital can be reduced. This provides an attractive method of operating for many private sector corporations today. Google is the best example of a large scale company utilizing the cloud. In fact Google's email service is based entirely on cloud computing and provides significant amounts of memory and utility as it can be accessed from anywhere. Further they have expanded their cloud services to their "Google Docs" application in which you can create and store documents online. The private sector is not the only organization to have noticed the advantages to cloud computing.

The Federal Government is quickly recognizing the value with cloud computing, both with efficiency and saved resources. Within the Federal Government many agencies have begun a migration, albeit a slow one, to the cloud in order to maximize savings to their respective budget. As an example "U.S. General Services Administration is the first federal agency to successfully migrate its employees to a cloud-based email service using Google Apps for Government."[1] With this move to a cloud based email service the GSA intends "to save millions in taxpayer dollars annually. We expect that using a cloud-based system will reduce email operation costs by 50 percent over the next five years and save more than $15.2 million for the agency in that time"[2] The Departments of State, Treasury, and Interior have also begun moving to a cloud based system within their organizations. The United States Army intends on moving all employees of the Army, both military and civilian, to a cloud based email service, saving over "100 million dollars annually."[3] This paper intends to demonstrate the benefits of cloud computing for the United States Marine Corps, as well as, address mitigation strategies towards concerns about risk within cloud computing.

As the United States Government faces the daunting task of reducing our overwhelming debt crisis, the Department of Defense, specifically the United States Marine Corps must make hard decisions with budget cuts to not only Operations and Maintenance Costs, Manpower Costs, but procurement costs as well. These costs can be offset through changes the Marine Corps could make internally. The Marine Corps needs to fully utilize the power of cloud computing in order to reduce spending and manpower, ultimately providing efficiency and savings.

Definition

This ability to access information via the internet is the essence of cloud computing. It provides the ability for the user to access documents, information, applications, or software anywhere in the world on any computer as it is all stored in what is referred to as a "cloud". The universally accepted definition for cloud computing, "as defined by the National Institute of Standards and Technology (NIST), a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction."[4] In plain English this means is the user's data or information is contained in a centralized location, such as a data center, able to be accessed through the internet from any location in the world with internet access. This provides the "on-demand" portion of the NIST definition. The "pooled resources" refer to any location that maintains the servers to house the information, software, applications, or infrastructure for the specific cloud that you are using. Darrell West of the Brookings Institution defines cloud computing simply as "services, applications, and data storage delivered online through powerful file servers."[5] What makes cloud computing attractive is you are able to quickly access your information without being tied to your local workstation at your workspace or home office. Additionally the speed at which you can access your information is improved.

History of Cloud Computing

While the ability to conduct cloud computing has come into vogue over the past decade, it was actually envisioned over 40 years ago. "Cloud computing, although new, was actually foreshadowed by John McCarthy back in the 1960's. McCarthy, a computer and cognitive scientist believed that eventually, compute power would be provided as a metered service."[6] John McCarthy, considered widely to be the father of Artificial Intelligence, described the use of computing and time-sharing at the centennial of the Massachusetts Institute of Technology (MIT) during a conference in 1961. During this conference McCarthy introduced the notion "that computer time-sharing technology might lead to a future in which computing power and even specific applications could be sold through the utility business model (like water or electricity)."[7] Later McCarthy reflected that his intent for that speech and the notion of time-sharing or what is now referred to as cloud computing was "an operating system that permits each user of a computer to behave as though he were in sole control of a computer, not necessarily identical with the machine on which the operating system is running."[8] Essentially as mentioned before time-sharing, or cloud computing, allowed each person to use a computer as if it were his or her system that was being used, but instead, consumers would be accessing the system from another location through the internet.

Arguably this concept was significantly ahead of its time as the internet had yet to be introduced to the lexicon of the world. Understanding cloud computing would be incomplete without a basic understanding of the evolution of the internet. In fact it was not until the late 1960s in which the Advanced Research Projects Agency (ARPA), what is now DARPA, created ARPANET. In response to the fear that the Russians could destroy the American phone system with one missile "a scientist from M.I.T. and ARPA named J.C.R. Licklider proposed a solution

to this problem: a “galactic network” of computers that could talk to one another. Such a network would enable government leaders to communicate even if the Soviets destroyed the telephone system.”[9]

Following Licklider’s solution and creation of ARPANET another scientist from M.I.T created a system to send data to each computer. Known as “Packet switching” it broke down information into small enough ”blocks, or packets, before sending it to its destination. That way, each packet can take its own route from place to place. Without packet switching, the government’s computer network—now known as the ARPANET—would have been just as vulnerable to enemy attacks as the phone system.”[10] Eventually as more and more computers were added to ARPANET and the resulting network, other networks were added around the globe, thus adding more and more computers to the network and ultimately the “internet.”

In order for each network to adequately work together they had to be able to recognize each other when they needed to pass or accept information. Vinton Cerf, who was also working for ARPA, had begun to solve this problem by developing a way for all of the computers on all of the world’s mini-networks to communicate with one another. He called his invention “Transmission Control Protocol,” or TCP. (Later, he added an additional protocol, known as “Internet Protocol... One writer describes Cerf’s protocol as “the ‘handshake’ that introduces distant and different computers to each other in a virtual space.” [11] The ability for computers to “talk” each other, as well as, packet switching enabled the use of information to be sent to each other over the internet.

Over time the overwhelming use of the internet led to significant amounts of data being collected and stored by individual users. The cloud addresses these issues by providing “scaleable and shareable resources over the Internet (Computing and storage ‘as a service)”[12]

This concept is exactly what John McCarthy referred to in 1961 during his speech to M.I.T. "Cloud computing gives users access to massive computing and storage resources without their having to know where those resources are or how they're configured."[13] Over the two following decades the world witnessed the rise of the personal computer through innovators such as Bill Gates with Microsoft and Steve Jobs through the Macintosh computer brand. Ultimately, the computer technology became more streamlined and efficient. It was not long before entrepreneurs recognized the power of computing and the use of the internet in our daily lives. At the conclusion of the 20th century one company was started that would have the largest influence on cloud computing. That company was Google.

Google has dominated the cloud services throughout the past decade. Their effort to "organize the world's data"[14] has brought great efficiency and access, as well as, concern over privacy of personal information and data. Examples of Google's efforts in the cloud are their email service known to most as Gmail. Additionally Google has created the ability for users to create and store documents in the cloud in order to collaborate with others, as well as, access these documents from any workstation. These services, along with others such as Google Calendars, Google Maps, Google+ (Google's answer to Facebook), have caused significant concern to many over the storage of so much personal data. Most would counter that utilizing Google for all of your personal needs creates efficiency. These concerns bring up the arguments and reservations many have over the future of cloud computing.

Benefits and Risks

The benefits and risks associated with cloud computing vary with the type of service and cloud you decide to use, but there are core concerns that all users who decide to utilize cloud services must confront and either reject or accept based upon the benefits cloud computing

provides. Advocates of cloud computing cite benefits such as efficiency, agility, and innovation. Executed properly these benefits can reduce overall operating costs.

The use of cloud computing can provide a level of efficiency previously not available to organizations. These "efficiency improvements will shift resources towards higher value activities."[15] Ostensibly through use of the cloud IT personnel can be reduced or provided focus on different areas of importance within the organization. Specifically "cloud computing can allow IT organizations to simplify, as they no longer have to maintain complex, heterogeneous technology environments. Focus will shift from the technology itself to the core competencies and mission of the agency."[16] Additional efficiency can be obtained through the reduction of IT personnel. Because the software utilized by personnel is maintained within a central data center and accessed through the cloud, numerous updates and patches to the organizations designated cloud software application can be executed at the remote data center by a relatively few amount of knowledgeable professionals. Rather than maintaining a cadre of IT professionals on standby to respond to trouble tickets or trouble calls these personnel can be reduced, leaving only the necessary amount of employees to manage and maintain the data center that holds the data and hardware to run the respective cloud. Darrell West cites a study in which "agencies could cut 15 percent of labor costs by moving to a cloud. But these savings are possible only if agencies actually cut personnel through cloud computing."[17] With the reduction of defense spending many in the federal government are beginning to look towards this option.

Today's environment is constantly changing and the development of technology, as well as, movement of information requires agility in order to stay ahead of their competitors. The Federal Government is no different. In order to remain a global leader, it must remain agile to operate within the global environment, this includes all aspects of national power. Cloud

computing provides a level of agility that the Federal Government does not maintain on its archaic computing environment it currently operates. "With traditional infrastructure, IT service reliability is strongly dependent upon an organizations ability to predict service demand, which is not always possible."[18] The ability to predict the need for service demand may seem benign within the DoD where the appearance of a fixed need for computing resides. But the ability to remain flexible and scaleable is at the heart of the DoD as a result of dynamic environment that it operates in throughout the globe and within each combatant command (COCOM). The DoD must be able to rapidly scale use of computer systems up and down as the need is demanded. "Notably, cloud computing also provides an important option for agencies in meeting short term computing needs…agencies need not invest in infrastructure in cases where service is needed for a limited period of time."[19]

Coupled with agility is the need for organizations to remain innovative. America has prided itself on innovation and providing solutions to complex problems in a changing environment. Cloud computing is no different. The Federal Government must remain innovative to continue ahead of emerging countries seeking a place on the world superpower stage. One quick way to remain ahead of emerging countries is to utilize the power of free thought by "adopting innovations from the private sector."[20] Because the private sector has captured and capitalized on the benefits of cloud computing it has provided a mature environment with which the Federal Government, specifically the Marine Corps can tap into in order to migrate from its existing structure to the cloud. The type of cloud used depends on the level of security desired and will be discussed. Cloud computing also provides the opportunity for public agencies to "take advantage of leading-edge technologies including devices such as tablet computers and smart phones." This opportunity will facilitate quicker innovative ways to

pass information, as well as, integrate familiar commercial products to federal employees. This would enable reduction in cost, as "new-start" technology could be eliminated in favor of using "Commercial Off-the-Shelf" technology.

Many opponents to cloud computing point out that a lack of security and overall privacy are substantial risks that would mitigate the need to adopt a cloud computing environment. Security issues are a risk that must be addressed when migrating to a cloud. Threats from hackers, loss of data, and decentralized information can provide an environment that could be exploited by the nation's enemies. These security risks are no more than the current threats on standard networks utilized today. In fact use of a cloud computing architecture could arguable increase risk as you spread the storage of information and use of servers across multiple servers and data centers via horizontal loading. Loading is a concept in cloud computing that seeks to take advantage of multiple servers in use at the same time. For example if there is an application running on one server and it becomes overloaded with users seeking to access that application, future users can be transitioned to the servers that have the same application in order to decrease the load on the original server and maintain processing speed. This is known as "virtualization" and is the essence of cloud computing. Additionally controlling the network and the information that resides in the cloud is a fundamental area that must be addressed and safeguarded, but can be done so responsibly and with appropriate cloud type selection and architecture build. Additional concerns with security surround protection of consolidated data centers. Consolidating data centers does present a physical security risk, it can also provide opportunities to focus more security measures and defense on a select data centers, rather than trying to protect a distributed data network that can be exploited easily. These security risks are not left to the individual organization to figure out. According to the CRTA Study of Cloud

Computing in the Federal Government "the Obama administration is requesting to allocate National Institute of Standards and Technology (NIST) a budget of $100 billion for developing needed policies and standards for cybersecurity and how they relate to cloud computing"[21]

Privacy concerns are a real issue as an organization's data is maintained in a centralized location that can be compromised by a select group of individuals that work within the data center. This concern does not provide any more risk that what the DoD, specifically the Marine Corps, already exercises with contractors possessing the ability to review and seek out specific content within email and internet use. The consistent vetting of employees and use of background checks must be continued in order to mitigate any internal threats that may compromise security and privacy. Currently there are a number of regulations that must be adhered to when migrating to the cloud, to include the "Federal Information Security Management Act (FISMA) and the Health Insurance Portability and Accountability Act (HIPAA)."[22]

While the risks of cloud computing can be substantial if compromised, they are no more problematic than security and privacy risks that already exist. Through the use of robust security measures, education, and monitoring these risks can be mitigated. In contrast the benefits of cloud computing offer cost savings not otherwise seen in the traditional IT infrastructure utilized by the Federal Government. The defense contracting company "Booz Allen Hamilton concludes that government agencies moving to public or private cloud can save from 50 to 67 percent."[23]

As mentioned cost-saving expectations are potentially substantial according to the Booz, Allen, Hamilton study, there are numerous studies that predict more and less savings through migration to a cloud. What is important to point out is savings can be expected, but these savings are based on the type of cloud that is utilized by an organization. The type of cloud, be it

public, private, or hybrid will swing the amount of storage utilized, as well as, the amount of security needed. Ultimately cloud computing will provide a streamlined and more accessible network to DoD employees, specifically the Marine Corps. For example the U.S. Air Force 45th Space Wing "had 60 distinct file servers, but found that it utilized only 10 percent of central processing unit capacity and 60 percent of random access memory space."[24] Through reduction of their file servers and "an internet cloud to link the data centers…Commanders estimate they save $180,000 per year in computing costs. This includes $104,000 in hardware costs, $30,000 in power to cool what used to be 60 file servers, and $28,000 in maintenance costs."[25]

Types of Clouds and Service Models

Each organization has its own needs for cloud services, some range from security, others to enable as much collaboration as possible across their company or designated population. There are four deployment models for clouds are public, private, community, and hybrid. Each one of these clouds will be discussed below, but to summarized the amount of security progresses significantly from public to private, with the hybrid cloud combining the benefits of both.

A public cloud is exactly what it sounds like. "The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services."[26] The advantages of the public cloud are they are easier to migrate to, as well as, cheaper to operate as a lot of the management and the maintenance of the cloud are executed by the owner of the cloud. The disadvantage to the public cloud is it provides the least amount of security due in large part to the lack of restrictions to access within the cloud. The community cloud "is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations)."[27] This

model provides for multiple parties using the same cloud. One example could be several agencies within the Federal Government or a larger organization that enlists like companies to share and spreadload the cost of the cloud services.

The private cloud provides the most attractive option for those agencies with significant security concerns. The private cloud "infrastructure is operated solely for an organization. It may be managed by the organization or a third party."[28] Finally the last accepted deployment model is the hybrid cloud in which you combine a public and private cloud in order to capitalize on the public cloud for less secure needs and use the private cloud to back up sensitive information or conduct more secure operations. Specifically the hybrid cloud "infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology."[29]

On top of the four deployment models there are three universally accepted service models. They are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). A diagram of these service models can be seen in Figure 1. At the lowest level of cloud services is the IaaS. IaaS is the "leasing of infrastructure (computing resources and storage) as a service…In essence, it's the capability of leasing a computer or data center with specific quality-of-service constraints."[30] The next level of service provided within a cloud is the Platform as a Service or PaaS. PaaS is a model in which the user can "deploy his or her own applications"[31] within the provider's cloud. "The consumer does not manage or control the underlying cloud infrastructure including, network, servers, operating systems or storage."[32] One example of PaaS is the Google Apps engine. Users can create applications then release them within the Google cloud. SaaS is the most common understood and identifiable cloud to those who are unfamiliar with cloud computing. Anytime you utilize a web-based email service

such as Gmail you are accessing the cloud via Software as a Service (SaaS). Anytime you order something from the internet you are using a cloud based service. A more formal definition for SaaS is the ability to access software over the Internet as a service."[33] While it would be easy to assume that a consumer can utilize just one service model, more than likely consumers will utilize all three in a "collection of services."[34]

Federal Government and Cloud Computing

Recognizing the importance of cloud computing within private industry, as well as, the cost savings that have been attributed with the correct employment of cloud services has been noticed by the Federal Government. The United States Chief Information Officer (CIO), Vivek Kundra, released the Federal Cloud Computing Strategy on 8 February 2011. In his executive summary he states the "Federal Government's current Information Technology (IT) environment is characterized by low asset utilization, a fragmented demand for resources, duplicative systems, environments which are difficult to manage, and long procurement times."[35] He goes on in the succeeding paragraph to state that "Cloud computing has the potential to play a major part in addressing these inefficiencies and improving government service delivery."[36]

Fundamental to cloud computing is not only the efficiencies that are gained through migration to a cloud, but the potential for real savings to operational cost and capital expenses. Because of these cost savings the White House instituted a "Cloud First" policy. The "Cloud First" policy is "intended to accelerate the pace at which the government will realize the value of cloud computing by requiring agencies to evaluate safe, secure cloud computing options before making any new investments."[37] What is important to note is it is not mandatory to move to federal organizations to a cloud, rather agencies should look at migrating to a cloud and determine if the benefits and value support migrating to the cloud.

Following this business case analysis agencies need to focus on what portion of their agency is appropriate to move to the cloud, additionally under what deployment model, i.e private, public, hybrid, or community. As part of the "Cloud First" policy and subsequent 25 Point Implementation Plan to Reform Federal Information Technology Management of December 2010 Vivik Kundra established that "Each agency will identify three "must move" services within three months, and move one of those services to the cloud within 12 month and the remaining two within 18 months."[38] The Department of Defense released their Department of Defense Information Enterprise Strategic Plan 2010-2012 to adopt the "Cloud First" policy. As part of this strategic plan the DoD must push toward a culture change from "stovepiped and service centric" networks to an environment of increased "network centric operations" and information sharing. Specifically the DoD CIO established six DoD Information Enterprise goals in order to expand information sharing and elimination of stovepipes. The first of these goals is "Information as a Strategic Asset"[39] Changing the view of information to one of a critical importance requires the aforementioned culture change, but it also moves the view of linking one user to another in order to pass information to a view of information residing in one place and all users access the information when necessary. To put it another way the information is grabbed by the user, not pushed to him or her. "DoD's transition from Component-centric, non-interoperable capabilities to joint net enabled capabilities will be accomplished with community based solutions…For greater efficiency, these services will be brought together in shared services centers or "Clouds"…that enable information flow from one domain to another."[40]

These clouds will need to be accessed at all times by those members given access to the respective cloud, be it public or private. The important piece is all uniformed services with the

Department of Defense need to begin actively moving to a cloud based computing architecture where it makes sense. "As the DoD moves further along the net-centric operations path, the Department must transform its infrastructure concept to support new service-oriented approaches, such as cloud computing and virtualization, for sharing, storing, processing and transporting information."[41]

The Marine Corps and Cloud Computing

Currently the Marine Corps is working toward a robust cloud infrastructure. But their entry into cloud computing is further than most other services when considering the true definition of cloud computing by NIST. The time for the Marine Corps to transition completely to cloud computing is appropriate when looking at the current budgetary constraints the United States economy is experiencing. The Marine Corps Private Cloud Computing Strategy establishes the vision for the future of cloud within the Marine Corps. Published 30 November 2011 the purpose of the "Marine Corps Private Cloud Computing Enterprise (PCCE) services will provide access from anywhere across the Marine Corps information environment at any time, via the Marine Corps Enterprise Network (MCEN) to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can rapidly be provisioned and released with reduced management effort."[42] Because the Marine Corps is an expeditionary service that prides itself on "being ready when the nation is least ready."[43] the vision and plans for cloud computing must address sharing information via the cloud in both a garrison environment and during expeditionary operations when Marines are stationed in remote locations that have limited bandwidth and internet access.

The Marine Corps solution for cloud computing both within the service and nested with the DoD and Federal Data Enterprise strategies is through the use of the Marine Corps Enterprise

IT Services program, otherwise known as MCEITS. The mission of MCEITS is to "provide enterprise IT services, service support and the infrastructure necessary to enable a secure, collaborative, interoperable information sharing environment for the warfighting and business domains."[44] One fundamental goal of this program is to "Deliver an Enterprise and Distributed capability aligned with the USMC Regionalization Concept and support an Expeditionary capability."[45] This focus on supporting Marines in an expeditionary environment is critical in order to rapidly provide data when it is needed. The cloud that supports the expeditionary environment must be able to address the challenges of limited bandwidth, over-the-horizon and satellite communications, rapid data updates, and the ability to replicate data aboard naval shipping and ashore that was constructed in CONUS. Overall the key thing that must be adhered to with cloud computing for the Marine Corps is "agility"[46] This agility must enable the Marine Corps to provide the necessary data to the warfighter when it is needed with little to no interruption in service.

Currently the Marine Corps is working to provide Infrastructure as a Service (IaaS) and Platform as a Service (PaaS). According to Maj Shawn Kelly, MCEITS falls short of legitimate cloud computing and PaaS in a few critical areas. "MCEITS (in my opinion) is not cloud computing, but more resembles traditional web-hosting. Of the five essential characteristics of Cloud Computing in the NIST definition, four have not been met by MCEITS Infrastructure; No on-demand self service, limited resource pooling, no rapid elasticity, and no measured service."[47] Additionally the MCEITs PaaS capability does not include ""programming languages, libraries, services, and tools" discussed in the NIST definition and key to PaaS are not provided by MCEITS at this time."[48] According to Major Kelly the prudent way to execute a cloud

computing strategy for the Marine Corps would be to start in CONUS, then expand OCONUS once the service is comfortable.

Garrison Cloud

A plan for establishing cloud computing and cloud services for the Marine Corps could be envisioned as establishing two large data centers in Kansas City and Albany. These data centers will provide the initial infrastructure to build capacity for the larger number of users, as well as storage space. This would constitute what is known as MCEITS at large (see Figure 2). In order to expedite the access to data required by Marines seven Marine IT Centers (MITCs) or "mini-data" centers would be established throughout the country in order provide faster computing speeds and processing power. This model would establish MCEITS Distributed. Additionally it will provide more servers with which the service could utilize for "virtualization". Virtualization is the key to cloud computing at the PaaS level in that it provides a level of redundancy and increased capacity and/or loading demands that would be needed during surge usage periods. The ability to provide surge capacity or reduce capacity without interruption to computing power is what is known as "elasticity." Upon reduction in need for a certain service, the use of requisite servers will decrease. This is the agility the Marine Corps needs. Additionally these data centers provide a level of security that counters the fear of many towards cloud computing. For most unaware of the potential or concept of cloud computing the fear of not knowing where their data is located and the ability of an adversary to hack into our data storage to exploit private information is countered by the spreading of data across these data centers. By spreading the data across different servers through the concept of virtualization or "loading" you effectively force your adversary to guess where the information is stored. Another way to imagine this concept is akin to the theory behind Operational Maneuver from the Sea

(OMTFS). By launching an amphibious assault from over the horizon towards an enemy coastline you force the enemy to decide to focus his efforts in one spot or spread his defenses. Similarly in cloud computing you force the enemy to guess where the data is stored as it is applied across different servers at random times predicated upon the load on other servers.

Expeditionary Cloud Computing

In order to sustain the expeditionary needs of the Marine Corps, naval shipping could be outfitted with a "mirror" image of the servers back home with the exact copies of software, applications, and data created in CONUS. Once afloat or ashore these applications could simply send back and forth the changes in data that occur within each document, thereby reducing the amount of data sent and saving critical bandwidth. This is the idea of Maj Shawn Kelley who stated that the cloud created afloat or ashore would mimic the distributed cloud at the MITCs or the overall larger MCEITs cloud at Kansas City and Albany. Going a step further this idea could be created ashore with another cloud. For example you could have a theatre cloud, that are then broken down into more clouds within the theatre. For contemporary application you could have an Afghanistan cloud as a sub-cloud of the CENTCOM cloud. Each cloud would have the same applications as the one higher or the clouds horizontally aligned with it in order to reduce the amount of bandwidth necessary to send information back and forth. As envisioned by Maj Kelley ostensibly you would send bits of data vice megabytes. Should there be a need to send large amounts of data, which is relative based upon the amount of bandwidth you have, you could set a priority list on who can send what data across the cloud. For example the transmissions from a company out-post would be lower on the priority list than that of intelligence needed from higher. What needs to be remembered is because the cloud is being

utilized does not mean we throw away our normal organic communications capabilities, such as SINCGARs or SATCOM radios.

Conclusion

The world is getting smaller as a result of the advances in computing and technology. The ability to access information has become easier and is made more efficient through concepts such as cloud computing. In the private sector the concept of cloud computing has become as transparent to the end user as legacy designs on information access. Cloud computing today is becoming the way in which end users access their information. Rather than obtaining data in a linear fashion, as was done in the past, similar to a phone line, users can now grab the information they need or utilize an application they desire by leverage the power of the internet. The ability to do this opens up a world in which the power of leveraging multiple servers as the foundation for the cloud are utilized to improve processing speeds, increase redundancy, and increase security. Knowledge and use of cloud computing within the federal government is on the rise and awareness of this concept, as well as the capabilities and benefits, are slowly making their way across all agencies and levels of our government. The Department of Defense understands the necessity to provide faster access to critical information at all times.

The DoD mandate to institute cloud computing will hopefully push our military capabilities further into the 21st century and provide us some level of leverage in the cyber domain against our adversaries. The Marine Corps is on the path to cloud computing, albeit slowly. While this paper is not advocating equipping expeditionary units with cloud computing capabilities first, rather the concept must be proven out in a benign environment, specifically in CONUS, in order to respond to any initial failures. Once best business practices are established the capability can be pushed forward to the warfighter. What is important to take away is the

Marine Corps needs to take that first solid step. While the service has a cloud computing strategy, the Marine Corps needs to fully embrace the power of cloud computing and its ultimate power to provide agility at all levels, from operational to tactical and the benefit to the strategic objectives and levels. Without taking risks organizations will not make gains. The Marine Corps needs to fully invest all available resources to cloud computing. We have always been a service of innovation, we need to continue this legacy and lead the DoD into the world cloud computing.

Figure 1
Cloud Service Models[49]

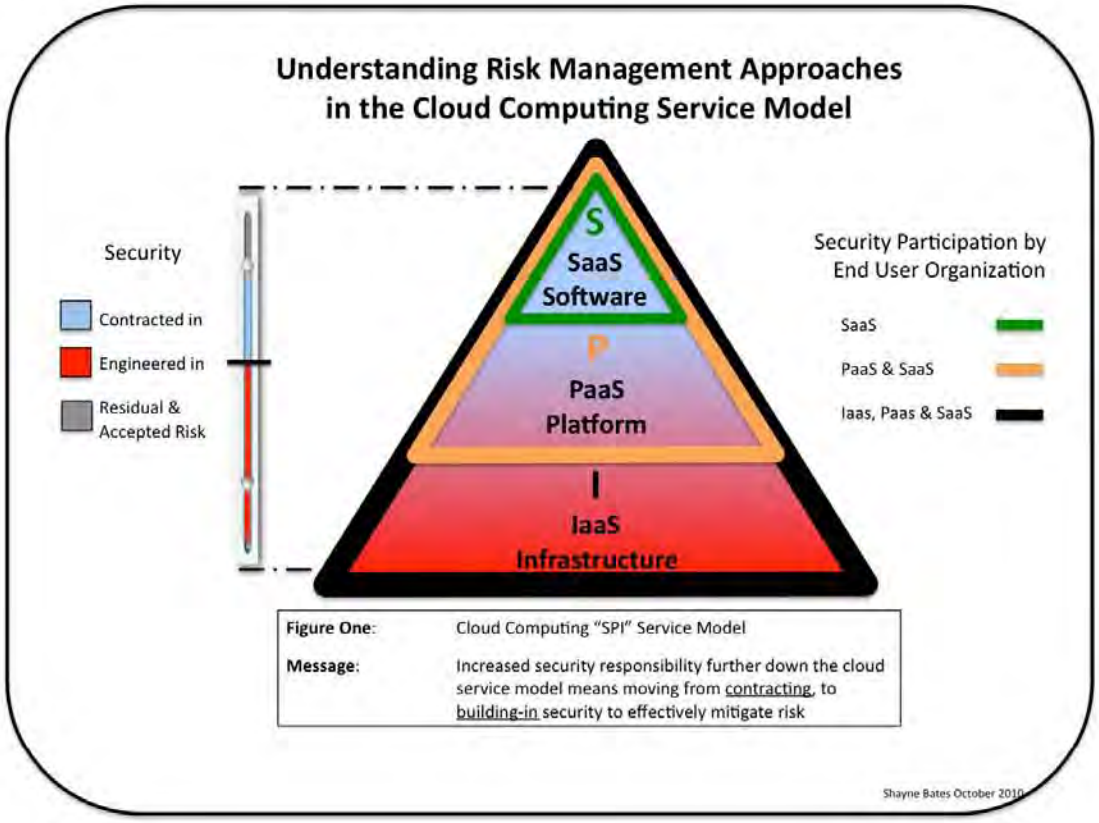
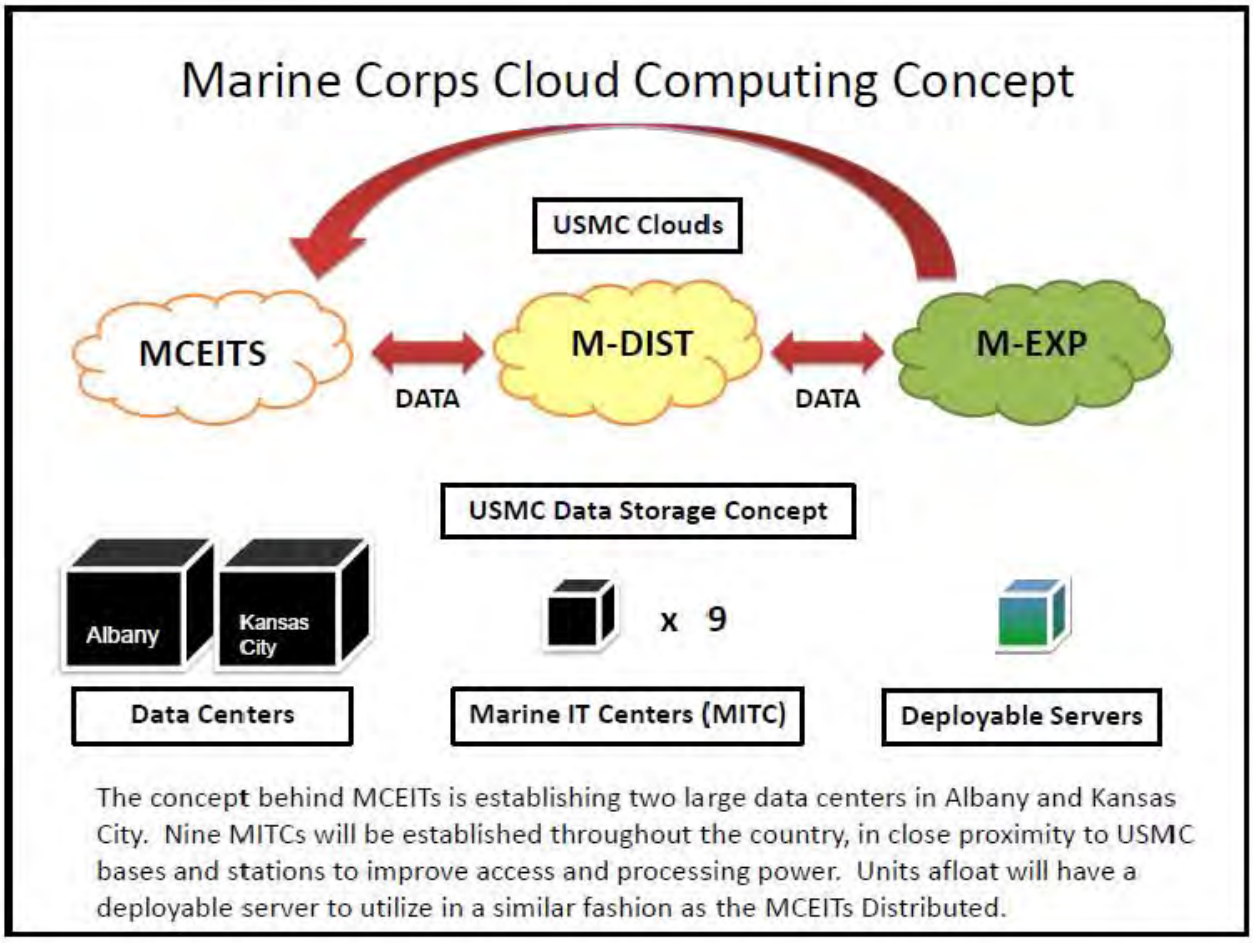


Figure 2


Marine Corps Cloud Computing Concept
USMC Clouds
MCEITS
DATA
M-DIST
DATA
M-EXP
USMC Data Storage Concept
Albany
Kansas City
x 9
Data Centers
Marine IT Centers (MITC)
Deployable Servers
The concept behind MCEITs is establishing two large data centers in Albany and Kansas City. Nine MITCs will be established throughout the country, in close proximity to USMC bases and stations to improve access and processing power. Units afloat will have a deployable server to utilize in a similar fashion as the MCEITs Distributed.

ENDNOTES

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